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(54) Title: FURNACE FOR HEAT TREATMENTS OF GLASS SHEETS

(57) Abstract

A furnace particularly for heat treatments of glass sheets (12), comprising a longitudinally-elongated chamber which contains roller conveyor elements (11) for the glass sheets (12). The furnace comprises irradiation-heating elements (13, 14) combined with first (18) and second (24) elements for heating by forced air convection in which the air temperature is controlled by adjusting its circulation rate, the elements being located respectively above and below the conveyor elements (11) and therefore above and below the sheets (12) being treated.

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FURNACE FOR HEAT TREATMENTS OF GLASS SHEETS

Technical Field

The present invention relates to a furnace particularly for heat treatments of glass sheets.

Background Art

It is known that a wide variety of glass sheets is currently commercially available, the mechanical characteristics whereof are often strongly dependent on heat treatments performed after producing said sheets.

In particular, one of the most important heat treatments applied to glass sheets is heat tempering.

Heat tempering facilities currently include a furnace constituted by a longitudinally-elongated chamber in which a roller conveyor conveys the glass sheets, which are heated to a temperature which is, by way of indication, between 620 and 700°C.

Two methods are currently used to heat said sheets: heat transmission by irradiation or heat transmission by convection.

Furnaces are currently commercially available which use one or the other of these heating methods.

However, there are also more advanced and complex furnaces which use both methods but do so alternately.

The means for irradiation heat transmission are currently substantially constituted by electrical resistors of the rod type with a ceramic core, by coiled electrical resistors which are suspended or contained in channels formed in the refractory material of the furnace, by electrical resistors of the panel type, or radiating panels supplied by gas-fired burners.

In furnaces that use heat transmission by forced convection, the air inside the chamber is instead channeled and recirculated by means of fans towards nozzles which project it onto the glass sheet surfaces.

The air can be heated by the electrical resistors located in front of the fans or by gas-fired burners, which heat it inside channeling ducts.

Although they are widely used, the above-described systems all have a common drawback, i.e., they are unable to uniformly heat the two opposite surfaces of the sheet being processed in order to avoid distortions thereof caused by temperature differences due indeed to the different heating conditions.

More specifically, the different heating conditions of the two surfaces arise from the different values of the overall heat transmission coefficients between said surfaces and the furnace environment.

These different boundary conditions in fact cause, in the transient thermal condition, an asymmetrical temperature distribution along the glass sheet cross-section.

The more conspicuous unevennesses furthermore occur when the glass sheet at room temperature (by way of indication, at 20°C) makes contact, inside the furnace, with the ceramic rollers, which are at a temperature of approximately 700°C.

The heat transmission coefficient due to the roller contact heat resistance is much greater than the transmission coefficient due to the irradiation on the upper side of the sheet.

This entails a much greater temperature increase on the

lower surface than on the upper surface.

Merely by way of indication, for glass temperature values below the limits at which relaxation effects occur (550°C), the temperature difference on the two surfaces entails a greater expansion of the lower surface, with a consequent warping of the sheet, which thus tends to become concave and touch the conveyor rollers only in the central part.

This highly negative effect produces, on the sheet surface, abrasions of different depths and conspicuousness which can cause the end product to be unacceptable.

This effect is also even more evident in the case of glass sheets coated on one surface with a low-emissivity coating.

Low-emissivity coatings in fact have the purpose of reducing heat transmission through the glass sheet.

Said sheets are thus coated in order to reflect infrared heat radiation (wavelengths between 2 and 20 micrometers), leading to a reduction in what is known as emissivity of the sheet surface.

In this manner, it is possible to obtain thermally insulating glass sheets with heat transmittance rates comparable with those of opaque portions.

When it is necessary to temper these sheets, the above-mentioned problem of heating the treated surfaces becomes even more significant, since it is not convenient to arrange the coated surface downwards, since it would make contact with the rollers and would deteriorate due to abrasion; however, if the coated surface is arranged upwards, the irradiation from the arch of the furnace is reflected and

accordingly an undesirable unevenness in heating occurs which further increases the problem of roller contact.

DISCLOSURE OF THE INVENTION

The aim of the present invention is to solve the above drawbacks of conventional commercially available furnaces, in particular by achieving high temperature uniformity on both surfaces of the glass sheet being treated, both when treating normal glass sheets and when treating sheets with surfaces coated with low-emissivity coatings.

Within the scope of this aim, an object of the present invention is to improve the quality of the product after treatment, avoiding the onset of heat-related stresses and the formation of surface abrasions.

Another object of the present invention is to provide a furnace in which it is possible to control and adjust the heating conditions of the sheets being treated.

Another object of the present invention is to provide a furnace which is particularly flexible from the operating point of view according to the type of sheet to be treated.

Another object of the present invention is to provide a furnace which has the advantages of convection furnaces and those of irradiation furnaces but does not have the corresponding drawbacks.

This aim, these objects and others which will become apparent hereinafter are achieved by a furnace particularly for heat treatments of glass sheets, of the type which comprises a longitudinally-elongated chamber containing roller conveyor means for the glass sheets, said furnace being characterized in that it comprises irradiation-heating means combined with first and second means for heating by

forced air convection in which the air temperature is controlled by adjusting its circulation rate, said means being located respectively above and below said conveyor means and therefore above and below the sheets being treated.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages of the present invention will become apparent from the following detailed description of an embodiment thereof, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is an orthographic projection view of part of a furnace according to the invention;

figure 2 is an orthographic projection view of a detail of the furnace of figure 1;

figure 3 is an orthographic projection view of another detail of the furnace of figure 1;

figure 4 is an enlarged-scale sectional view of a detail of one of the holes for blowing air above the sheets being treated, showing the speed profiles of the corresponding air jet.

WAYS OF CARRYING OUT THE INVENTION

With particular reference to figures 1 to 3, a furnace for heat treatments of glass sheets, according to the invention, is generally designated by the reference numeral 10.

The furnace 10 comprises a longitudinally-elongated chamber, not shown, which contains roller conveyor means, generally designated by the reference numeral 11, for the glass sheets; only one of said glass sheets is shown in the

figures and is designated by the reference numeral 12.

The furnace 10 comprises irradiation-heating means combined with first and second means for heating by forced convection of air whose temperature is controlled by adjusting its circulation rate; said means are described hereinafter.

More specifically, the furnace 10 in fact comprises, above the roller conveyor means 11 and therefore above the glass sheet 12, a combination of the irradiation-heating means and of the first convection-heating means.

There is a plurality of radiating panels 13 made of refractory steel which are arranged side by side and longitudinally along the advancement direction of the glass sheets; a heating unit, generally designated by the reference numeral 14, is associated with each radiating panel and is arranged above it; each heating unit is constituted by a radiating electric resistor 15 which has a curved reflecting panel 16 arranged in an upward region.

The figures also show, for each one of the electric resistors 15, the insulated electrical connections, designated by the reference numeral 17.

Each one of the radiating panels 13 is provided with holes 18 for the passage of hot air, which strikes the upper surface of the glass sheets 12 being treated when exiting from said holes.

In particular, each one of the holes 18 is shaped so as to have a flared portion 19 directed towards the corresponding heating unit 14.

More specifically, the hot air that exits from the holes 18 is drawn from inside the chamber of the furnace 10

by fan means, designated by the reference numeral 20, and is then pushed through ducts 21 towards the electric resistors 15 and, once it has struck said resistors, towards the radiating panels 13, from which it exits through the holes 18.

In figure 1, the reference numeral 22 designates the profiles of the air jets at the exit of the holes 18.

The particular configuration of the holes 18 allows to give the air particular speed profiles (designated by the reference numerals 27, 28 and 29 in figure 4), which studies conducted by mathematical simulation have shown to be particularly effective for temperature uniformity, particularly in the first heating periods, which are the most critical.

The speed of the air that exits from the holes 18 can be adjusted by regulating its flow-rate by means of an electronic control of the speed of said fan means 20, which feed said air into a distribution duct 23 connected to the ducts 21.

The second convection-heating means comprise, below each one of the roller conveyor means 11 and therefore below the glass sheet 12, a plurality of heating elements of the electric-resistor type, designated by the reference numeral 24, which are arranged longitudinally to the advancement direction of said sheets.

Each one of said heating elements 24 is contained in a corresponding box-like body 25, from which nozzles 26 protrude; said nozzles are meant to distribute, in the region below the glass sheet 12, the hot air drawn by fan means (not shown in the figures) from the chamber of the

furnace 10.

The arrangement of some nozzles is such as to force the air to directly strike the lower surface of the glass sheet 12, whilst other nozzles force the air to directly strike a corresponding roller of the conveyor means 11.

The temperature of the air that exits from the nozzles 26 is such that by striking both the glass sheet 12 and the rollers of the conveyor means 11 it heats the glass sheet and cools the rollers, significantly contributing to even out the temperatures and the overall heat exchange coefficients, also in relation to those of the upper face of the glass sheet 12.

In practice, it has been observed that the present invention has achieved the intended aim and objects.

In particular, it should be noted that the furnace according to the invention, by appropriately combining irradiation heating and forced-convection heating with temperature adjustment allowed by adjusting the air circulation rate, controls the balance of the heating conditions on the surfaces of the sheet being treated.

Accordingly, with the furnace according to the invention it is possible to achieve a satisfactory distribution of the temperatures on the glass sheet, substantially eliminating entirely both sheet warping and abrasion of the surfaces of said sheet.

It is also noted that the furnace according to the invention provides these uniformities in a substantially simple and flexible manner.

The possibility to adjust the temperature by adjusting the air flow rate causes the furnace according to the

invention to be adaptable to the treatment of even substantially different glass types.

In particular, the furnace according to the invention substantially completely solves the severe drawbacks caused by the treatment of glass sheets with low-emissivity coatings.

The present invention is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept; likewise, the details may be replaced with other technically equivalent elements.

The materials and the dimensions may be any according to requirements.

CLAIMS

1. A furnace particularly for heat treatments of glass sheets, which comprises a longitudinally-elongated chamber which contains roller conveyor means (11) for the glass sheets (12), said furnace (10) being characterized in that it comprises irradiation-heating means (13) combined with first (18) and second (24,26) means for heating by forced air convection in which the air temperature is controlled by adjusting its circulation rate, said means being located respectively above and below said conveyor means (11) and therefore above and below the sheets (12) being treated.

2. A furnace according to claim 1, characterized in that the air speed is regulated by adjusting its flow-rate through holes (18) for emission towards the sheets (12) being treated by controlling the speed of fan means (20) which produce the flow of said air.

3. A furnace according to claim 1, characterized in that said irradiation-heating means and said first forced-convection heating means comprise, above said roller conveyor means (11) and therefore above the sheets (12) being treated, radiating panels (13), each of which is brought to the preset temperature by an overlying heating unit (14), and is provided with said holes (18) for the passage of the hot air that strikes the upper surface of the sheet (12) when exiting.

4. A furnace according to claim 3, characterized in that each one of said radiating panels (13) is arranged longitudinally and parallel to the direction of advancement of the sheets (12) being treated.

5. A furnace according to one or more of the preceding claims, characterized in that each one of the heating units (14) related to said radiating panels (13) is constituted by an electric resistor (15).

6. A furnace according to claim 5, characterized in that each one of said heating units (14) is provided with a curved reflector panel (16) arranged above each electric resistor (15).

7. A furnace according to one or more of the preceding claims, characterized in that it comprises ducts (21), provided with said fan means (20), for drawing air from the chamber and for conveying it towards said heating units (14), towards said radiating panels (13) and towards said exit holes (18).

8. A furnace according to one or more of the preceding claims, characterized in that each one of said holes (18) formed in said radiating panels (13) is shaped so as to have a flared portion (19) which is directed towards the corresponding heating unit (14) and determines a preset flow-rate profile (28) of the outgoing air.

9. A furnace according to one or more of the preceding claims, characterized in that said second convection-heating means comprise, below said conveyor means (11) and therefore below the sheets (12) to be treated, a plurality of electrical-resistor heating elements (24) which are arranged longitudinally to the advancement direction of said sheets (12), each heating element (24) being contained in a box-like body (25) from which nozzles (26) protrude in order to distribute the hot air, which is guided so as to strike, at preset speeds, both the sheets (12) being treated and the

rollers of said conveyor means (11).

10. A furnace according to claim 9, characterized in that said nozzles (26) are constituted by a plurality of tubes, in which at least one set is directed towards the sheet (12) being treated and at least one set is directed towards a corresponding roller (11).

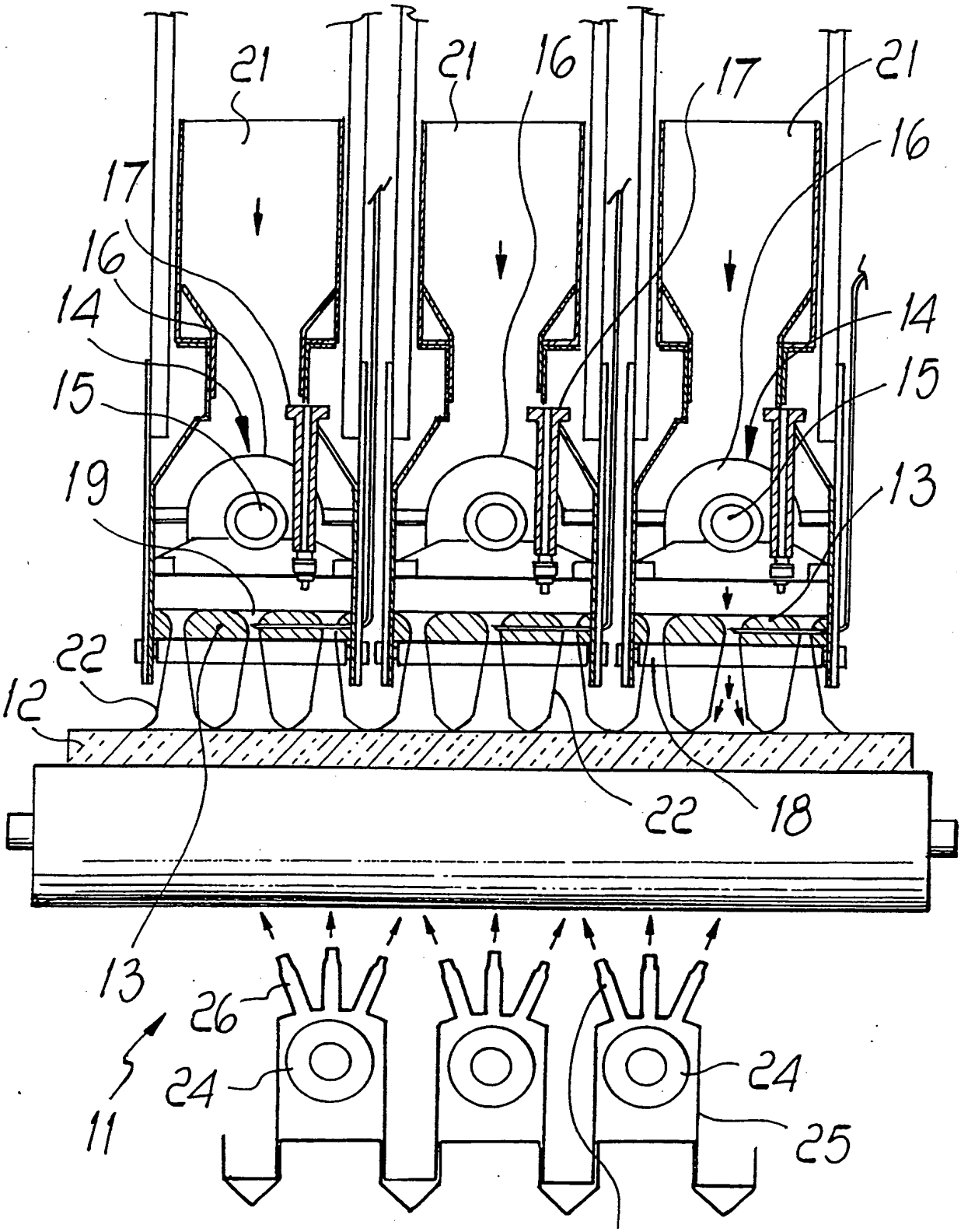
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Fig. 1

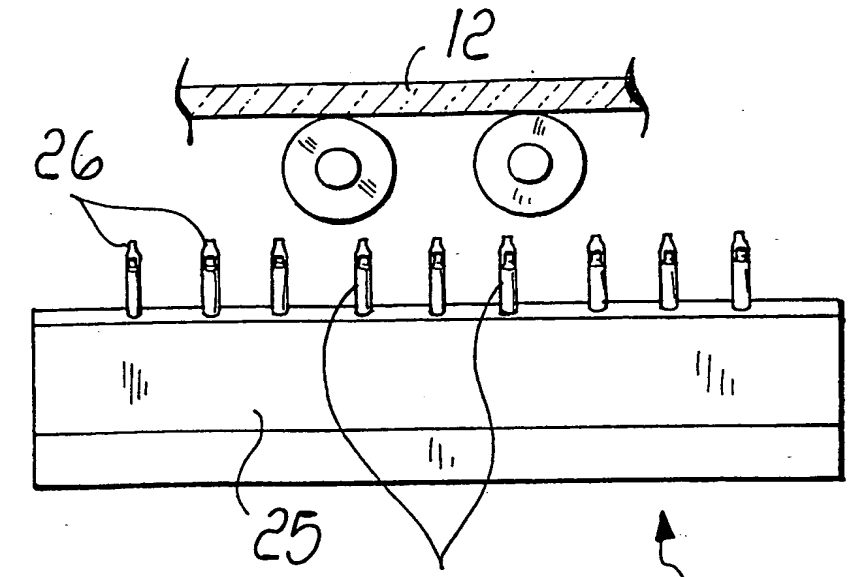

Fig. 2

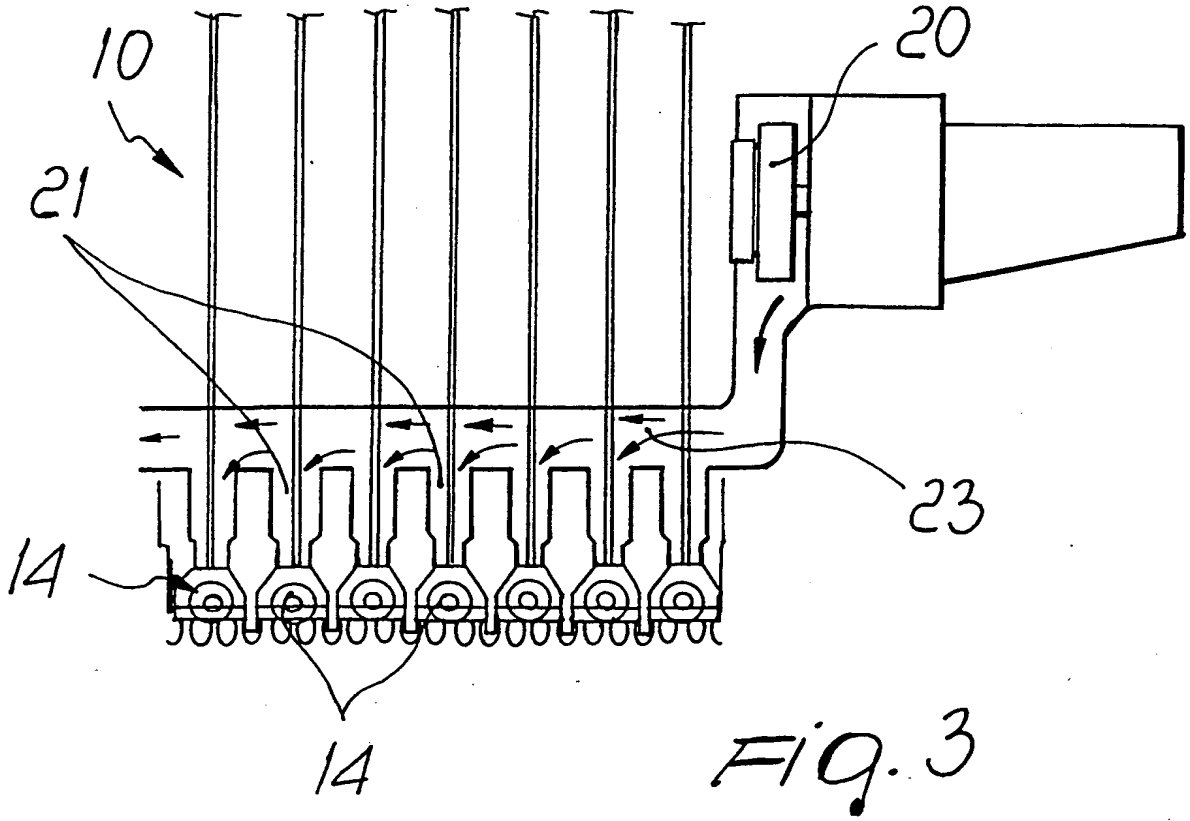

Fig. 3

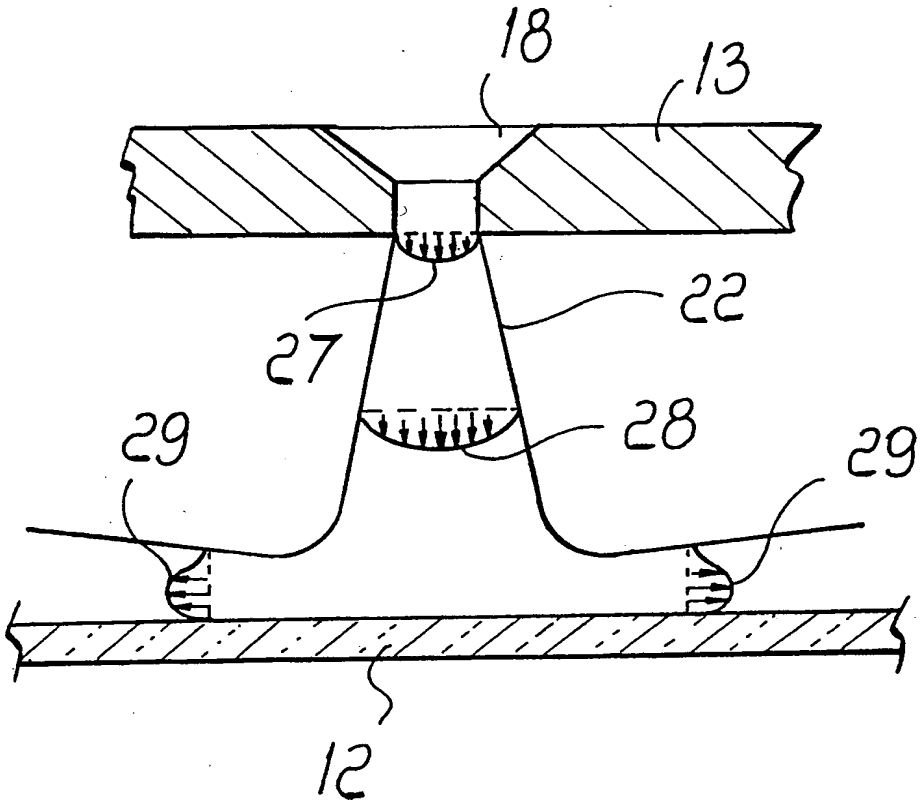

Fig. 4

INTERNATIONAL SEARCH REPORT

Internatio Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C03B29/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C03B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 0 249 361 A (GLASSTECH,INC.) 16 December 1987 see the whole document ---	1-10
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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